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GENERAL SCIENCE.—*The new Aristotle.*[1] FREDERICK BARRY, Columbia University. (Communicated by C. E. CHAMBLISS.)

To those students of the history of science whose interests are—so to say—more scientific than historical, whose experience in the production of new knowledge has made particularly vivid the realization that discovery is far less frequently the result of happy accident than the consequence of systematically methodical investigation, and not so often the reward of mere industry as the fulfillment of theoretical anticipations—in a word, to ourselves, the most significant of all past scientific labors are those which have contributed either to the determination of effective ways and means in research or to the development of that conceptual representation of nature which enables us in some degree to understand the complicated interrelations of diverse phenomena, to organize our knowledge as it grows, and to discern the most promising pathways of further investigation.

It is common knowledge that we owe to the ancient Greeks, uniquely, not only the first inculcation of the scientific temper among thoughtful men and the first studies of nature that were exclusively guided by the disinterested spirit of free inquiry, but also the permanent establishment and extensive development of the basic principles of scientific method and the first theoretical correlations of positive knowledge. Among them the scientific habit of thought was born; and, during the eight hundred years that fate allowed for its vigorous development, was completely matured, both by introspective analyses of the natural processes of inference which yielded the principles of rigorous logical and mathematical procedure and by critical studies of the limitations of natural knowledge which yielded our characteristically pragmatic philosophy of suspended judgment.

On the other hand, the problems presented to the ancient theorists by natural phenomena commonly observed were sufficiently difficult to tax the acumen of their keenest and most subtle understanding.

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The record of their scientific achievement, therefore, does not reveal much evidence of the investigation of those hidden regularities in natural processes that now interest us most; which, as we know, are revealed only by the experimental disentanglement of superimposed effects. Their theoretical physics was practically restricted to the mathematical representation of the most patent phenomena—those of geometrical configuration, apparent celestial movements, mechanical equilibria and the reflection and refraction of light,—and the rest of their natural philosophy remained in the condition of preliminary qualitative generalizations little more than descriptive. In comparison with the subtlety of their critical and methodical work, their theory, consequently, seems to us for the most part surprisingly simple and even naïve. We have so completely assimilated their mathematics, which remains the foundation of our own, that even when we remember its origin we forget that to them it was not at all a purely conceptual technique, but on the contrary a natural science; and since the rest of their physical theory, based on a necessarily meagre knowledge, has now become largely obsolete, it is very easy for us, naïvely on our own part, to dismiss it from serious consideration with reference to the progressive development of science, by pronouncing it wrong rather than incomplete. If, nevertheless, curiosity leads us to examine somewhat critically the content of ancient theory, it is not long before we realize that its falsity is precisely like that of all later scientific representations of nature that have been successively invalidated by the growth of knowledge; that the suggestive conceptions it embodied have assisted rather than impeded the development of later theory, and that they have been by no means so frequently discarded as progressively modified in conformity with the advance of knowledge,—in other words, that, contrary to first impressions, ancient theory was incomplete rather than wrong.

That such is the case is clearly due to the methodical predilection of the Greek natural philosophers. Their original motivation was pure curiosity: they desired, as Aristotle said, to know; not like their predecessors to seek security and advantage by magical participation in the mysterious potencies that seemed to control an external world more feared than loved, nor to find the satisfaction of desire and longing in poetical and religious imaginings of its nature, but in accordance with their cheerfully confident and rational predisposition to discover its immanent reasonableness, which they never doubted, and to depend on that. For men of this temper it was nothing more than obedience to the dictates of common sense to turn, when baffled in their

first attempts to discover this reasonableness by simple unguided observation of the confused and restless world about them, to the more careful study of ways of knowing. Nothing more strikingly illustrates their acuteness than that, having once confirmed their instinctive expectation by the discovery of certain regularities of interrelation among natural configurations and recurrent processes, they devoted their later efforts primarily to the problems of understanding; for they appear to have appreciated even then, as clearly if not as vividly as we do ourselves, that valid theoretical knowledge depends unconditionally upon the practise of sound method, and therefore that the determination of effective and dependable procedures alike in research and in conceptual correlation are necessarily prior to the productive investigation of phenomena in detail.

These philosophers thus became the pathfinders of natural science; blazed the passable trials that penetrated her rough domain, cleared them, and erected upon the secure foundations thus discovered the first watchtowers from which that domain could be surveyed, or, as they themselves expressed it, could be *theorized*. This was their great achievement; and the work was so well done—with a discriminating care so cautious that often our superficial critics even blame them for it—that though we have since widened and extended the ways they chose and rebuilt their theoretical structures, we have, after centuries of further exploration, neither abandoned those ways nor disturbed the foundations that they laid.

The most productive and influential of all these ancient methodical theorists was Aristotle, whom our ancestors for centuries venerated as The Philosopher, and whom we as well must still accord, I think, this uniquely distinctive title. It is probable that no individual thinker has ever so stimulated and developed the critical thought of other men. His conceptions have become a part of our intellectual heritage and, variously interpreted, affect profoundly—whether or not we are conscious of the fact—not only the character of our unconsidered preconceptions, but in considerable degree the philosophic temper which determines the criteria of our reasoned judgments. This circumstance makes unusually important all studies which yield us clearer insight into the original meaning of his philosophy, accentuating their historical value which is great on its own account.

I wish this evening to discuss,—not of course at all thoroughly but, if I can, suggestively,—certain implications of one such study recently made which appears to me to be quite unusually significant, particu-

larly with reference to its scientific bearing. Accept these remarks, if you please, not as a critique—I make no pretence of scholarly competence in the matter—but rather as a brief commentary, of the nature of, let us say, a report such as an observer with scientific interests might be expected to submit on the findings of recent research in a field not his own. These findings will supply my text; the sermon, for better or for worse, must be an interpretation essentially personal, even though it develops only immediate inferences, more or less obvious and in probable accord with most well-considered opinion.

The work to which I refer is Werner Jaeger's admirable study, *Aristoteles*, which appeared a year or so ago and is now available in a very pleasantly readable translation. This book, there can be no doubt, must be read by everyone who is seriously interested in the larger and more important issues of the history of thought—and particularly, so I think, those of the history of scientific thought. For myself it had peculiar interest, since its thesis, convincingly supported by scholarly arguments based upon the results of protracted and minute research and coördinated by an unusually scrupulous constructive imagination, brought into clear definition the substance of suspicions I had long entertained but could not, for lack of sufficient historical and scholarly knowledge, justifiably express: namely, that the Aristotle with whom the professional philosophers have made us familiar was not, any more than the Aristotle of the scholastics, the veritable ancient thinker, but rather a legendary figure—the product of a persistent theological—or, if you prefer, a metaphysical—predilection in speculative thought, which, having its roots in our common background of Christian belief, has, as everybody knows, determined the motive and contributed largely to the substance of all systematic philosophy from Spinoza to Hegel, and provided the guiding undercurrent of its most influential dialectical criticism from Berkley to the present time.

This philosophical tendency has, throughout the modern period, predominated in our institutions of learning, and is, I think, quite properly, and not at all accidentally, called Academic; for its spirit and method, essentially unmodified by the successive invalidation of particular dogmas and unaffected by the scientific habit of thought which antagonizes it, remain essentially the same as those originally inculcated by Plato; and as common thought becomes progressively more critical, its doctrines acquire an increasingly vivid pre-Christian coloring, reverting more and more definitely to the abstract conceptual idealism of this first philosophical supernaturalist. I can now

do no more than suggest in this way, by reference to its derivation, the general character of that type of philosophical thought which until very recently has wholly prevailed among the learned, and through the control of higher education by conservative institutions in their development from monastery and cathedral to university has, by perpetuating and continuously fortifying the idealistic attitude and its doctrinal presuppositions among scholars, practically determined the point of view from which the philosophy of the past is almost universally interpreted and evaluated. It has required no conscious effort to accomplish this: our common religious feeling, our moral aspiration, our necessary belief in the real significance of human life itself, inevitably seeks and usually demands the sanction of a transcendent reality beyond ourselves and beyond the world we know to sustain our labors and to guide them. The idealistic philosophy responds to all such needs. Even its coldest intellectual formulation focuses attention on the eternal, the changeless, the universal; and in one manner or another conceives it necessarily as mind, which alone can be thought of as immaterial, and so incorruptible and abiding.

Plato separated such an ultimate reality from the perceptible world of change and turmoil and imagined it as prior, self-subsistent and dominated by an immanent Good; Aristotle conceived it as immaterial Form, of which the physical world was an embodiment, developing in successive stages through particular forms from the gross and transitory to the ethereal and eternal under the control of a divine Purpose. Is it to be wondered at that in Christian Europe the names of these great men, who at one time were master and student, should be associated in thought and interpreted with reference to those most abstract and general of all their ideas, which refer to the ultimate problem which not Christians alone, but earnest men of all peoples in all ages have considered the gravest and most profoundly significant? Is it to be wondered at that endless labor should have been expended in efforts to reconcile their explicit contradictions; that in the failure to effect this reconciliation, those rationalistic philosophers who, unlike the theologians, could not escape their dilemma through denial of the final adequacy of reason and acceptance of revelation in its place, should seek refuge in some new variant of the Platonic realism, evading the arguments by which Aristotle had invalidated it by arbitrarily rejecting the very premises of his contradictory theory of knowledge? And finally therefore, is it to be wondered at that, in the ensuing turmoil of dialectical disputations, the distinctive character

of his philosophy—which, after all, is based on common sense and with respect to its fundamental principles is as clearly understandable as one would expect an eminently logical naturalist to make it—has been somehow lost to common view?

Whether or not it is to be wondered at, such is the case. In a word, the traditional Aristotle is not the portrait of any possible philosopher. It is a composite photograph of a single man facing opposite ways. One figure, rather faintly outlined, is that of a man who studies the actual world, writes elaborate works about the earth and the stars, about the forms and habits of animals, their anatomy and physiology, about man and his society, his art and the history of his thought and institutions; who derives all knowledge from experience, identifies the real with the actual and constructs a hesitant theology inductively from a logical interpretation of the phenomena. The other, much more distinct, is a transcendentalist who perceives that all that is incorruptible and permanent in nature is immaterial, that the essence of reality is disembodied form, the particular manifestations of which change perpetually in a process of development toward the changeless and eternal under the direction of divine power immanent in the whole, who therefore conceives the universal to be prior to and determinative of the particular, and reasons accordingly, inferring by means of an irrefutable deductive logic which he designs and subtly elaborates for the purpose, the essential character of particular realities from necessary universal premises: his only significant divergence from the thought of his great master Plato being occasioned by a less penetrating insight which permits him still to indulge a youthful ardor in studying the imperfect and distorted images of sense impression, and—perhaps under the influence of a personal ambition to be original—to devise an empirical theory of knowledge, the inductive logic of which he never perfects for the simple reason that this is impossible.

For the sake of clearness I have sharpened the actual outlines of this contrast; as a graphic pattern, however, it is correct. Both men pictured are lovers and students of nature, and both are empiricists, though one is earnestly and emphatically so, clearly conscious of the full import of this theory of knowledge, while the other is either weakly self-deceived by early predisposition or guilty in some sense of sophistry. On the other hand, both identify the permanent and changeless in experience as the ultimate reality, and conceive it as immaterial; but to the one its immateriality is conceptual, to the other it is transcendental. In other words, both see that the elements of

all knowledge are general ideas, but to the one these universals are generated in human thought by the perception of similarities and differences among particular sensory impressions, to the other they are preëxistent and are only discovered in this way; to the one, consequently, they are derivative, to the other prior. In general, therefore, according to the one true knowledge is to be arrived at only through a carefully laborious inductive process checked at every stage by the criterion of consistency, while to the other this process is unnecessary beyond a certain point, since true knowledge finally arrives through immediate intuitive recognition of the preëxistent universal, and by the deductive elaboration of its implications.

I think that the fundamental contrast is most clearly illustrated by this last antithesis. The one Aristotle reasons on the basis of empirical postulates, deriving concepts of increasing generality from the study of particular phenomena, inductively,—*a posteriori;* the other reasons from transcendental postulates, discerning by direct intuition immediately the general ideas that are only indicated by the final process of induction, and deriving from them implications of increasing particularity, deductively—*a priori.* In the philosophy of one the transcendent metaphysics is a superstructure, in the other it is a foundation. The one calls his general theory—which we call the Metaphysics—First Philosophy, which is practically equivalent to what Herbert Spencer called First Principles; the other calls it Theology. The faint Aristotle is both temperamentally and methodically a scientist, the more vivid Aristotle is a dogmatic metaphysician.

It must not be supposed that either of these portraits is a misrepresentation: evidence enough can be found in Aristotle's treatises to make both of them plausible. Until the time—toward the end of the nineteenth century,—when the influence of scientific positivism began to make itself felt in the world of philosophical scholarship, the picture of Aristotle the metaphysician almost completely obscured the other. When Zeller wrote, however, and afterward, that of the scientist emerged more clearly. It remained, nevertheless, in the background; and excepting in the thought of investigating scholars, remains there still.

I think that we may account for this persistence of an old impression by ascribing it not only to the force of habit but to two other causes at least: first, to the fact that, even among philosophers other than idealists—probably among all of them excepting a few radical empiricists, pragmatists and sceptics—the basic purpose of philosophy, if it is to be distinguished from science, still remains the Quest

of the Absolute; second, to the fact that scientists, who among all men would be most likely to grasp the full import of Aristotle's theory of knowledge and reality, offer little or nothing to the discussion, for the adequate reason that usually they accept without question the traditional view of him, and as a natural consequence seldom read his works at all. This will be evident to anyone who glances at the earlier chapters of our typical summaries of the history of science.

Here one always finds some reference to the great Stagirite, for his historical importance cannot be ignored; but this reference is brief, and its usual implication is to this effect: that he was a subtle dialectical thinker who attempted on the basis of reasonable but arbitrary presuppositions to excogitate once and for all the ultimate nature of things, and succeeded in constructing a cosmology so impressive that it imposed itself like an incubus on the thought of men for nearly two thousand years, making impossible any significant progress of natural knowledge until its hold was broken by the destructive criticism of Bacon and the experimental investigations of Galileo; that this repressive influence was due to its perpetuation of old Greek representations of nature which were the final results of a succession of naïve hypotheses quite unsupported by experimental evidence, subtly elaborated by deductive reasonings *a priori*, and supported by dialectical arguments purely logical in the characteristic manner of the Greeks, whose scorn of vulgar labor inhibited their scientific development by restricting their thought to the domain of pure ratiocination; that Aristotle is to be credited with an effort to promote the study of nature and particularly that of animal life, but that, sharing these limitations and guided by an unusually intense desire and aptitude for synthetic conceptual generalization, he ultimately produced little more than a transcendental metaphysics, the only positive achievement involved in which was the development of formal logic; that this is sufficient to secure his fame, but that his philosophy as a whole cannot properly be called science at all, involving, as it does, conceptions of immanent potency, vital force and abstract notions of causality derived from the idea of a guiding mind and purpose in nature, and culminating, as it does, in a theology; and that, finally, his simply descriptive biology is vitalistic, his psychology animistic, his chemistry merely an empty occult theory of subsistent forms and qualities, and his physics, which at least is positive, arbitrarily dogmatic and wholly wrong, especially with reference to falling bodies.

Now, even this estimate cannot be said to be wholly unjust. It is

that which a scientist must in candor make, when, accepting as is reasonable the expositions and commentaries of the historians of philosophy, he evaluates the work of Aristotle from his own point of view. If, however, curiosity leads him to examine these presentations in his customary way, separating explicit statements of particular conceptions and doctrines from their argumentative context, comparing them with reference to their diverse implications, and thus inferring, without reference to past opinion, their common ground, he will then certainly begin to suspect that, false though Aristotle's picture of nature may be, there is the possibility that its falsity may not after all be that of a synthesis based on premises and guided by habits of reasoning fundamentally wrong, but rather that of a genuinely scientific theory of nature that has been invalidated by new knowledge, like Copernican astronomy or Cartesian mechanics, like the corpuscular and caloric theories of light and heat, or Stahl's phlogiston theory, or Lamarck's theory of evolution, or—dare I say—Bohr's theory of the atom; concerning all of which one may assert, as the curate at the Bishop's breakfast table said of the eggs served him, that parts of them are excellent.

If this suspicion engenders sufficient courage, he will then read the original treatises. This will be difficult, even in translation. The *Metaphysics*, to which he will have been invited first to turn, is not consistently sequential, and its form in detail is imperfect; the diction is very often turgid and elliptical, there are reiterations and cross-weavings of slightly variant arguments and criticisms which cannot be understood without further knowledge of the antecedent and contemporary philosophy; and often the parts cannot be made clear without a knowledge of the whole. Each in its own way, the other theoretical treatises offer like difficulties. The subtle elaboration of the *Analytics* is intolerable; the *Physics* is a mass of discussions wholly concerned with abstract generalizations. Throughout, the arguments by appeal to reason wholly predominate, and it is the logician who passes judgment, though the grammarian is always at his elbow appealing to common sense, and the observer contributes to the evidence adduced. Altogether, the first impression gained from this reading is such as to discourage the hope of finding here much of science as we know it, and to concede to the philosophers the reasonableness of their traditional evaluation. When the broad outlines of the system become clear, however, when the whole becomes in this sense known, the scientist whose presence we first suspected again emerges; but

still he is far from dominating the metaphysician, and it becomes even clearer why the traditional figure has always been composite and inconsistent.

But now, suddenly and convincingly, this age-long difficulty has been resolved: not by further rational analysis of the content of the treatises as they stand, but by an historical investigation which has at last presented to us clearly outlined, in place of the static sculptured figure of tradition, the picture of a living man; and in place of the conglomerate collection of his writings, which scholars heretofore have been forced to interpret all at once as if they were the product of a single mind, at least two groups of writings composed at different times and guided by the changing basic conceptions of a rapidly maturing critical thought.

This is the work of Jaeger. I cannot here and now, of course, stop to present his arguments: granting the facts he adduces, as we always must and do grant them in discussing the results of highly reputable scientific research, I shall only say that his inferences, based on a considerable mass of data both historical and literary, seem to me to involve a surprisingly slight and inconsequential amount of conjecture and to be wholly convincing—the more so since I can imagine no conclusions opposed to those he draws to be consistent with the historical evidence that refers to the thought and work of Aristotle's immediate disciples. In broadest outline, then, let us survey in the light of Jaeger's findings, the course of their master's intellectual development.

When as a youth of seventeen,—born of a family of physicians and bred under the influence of the naturalistic habit of thought which the Ionian medical schools had long inculcated among men of that profession—he left his father's home in Stagira and came to Athens, the Academy of Plato had already been solidly established as the stronghold of the most conservative philosophical tradition of Greece. It was not a centre of important scientific activity: indeed it had never been that. To the Ionian philosophy, the first science properly so-called—the first disinterested, objective, exclusively rational and freely critical investigation of nature, which had culminated in the atomic theory of Leucippus and Democritus and the physical astronomy of Anaxagoras—Plato, like his venerated teacher Socrates, remained completely indifferent. To the great sophists of the preceding generation, contemporaneous with Socrates, who had laid the foundations of that empirical and critical epistemology which later produced

the sceptical philosophy of suspended judgment that we now call scientific, he was sharply antagonistic. Their humanistic interest he shared, and his original motivations were wholly ethical and political; but his intentions were reactionary, and his earlier philosophical work was guided by the purpose of establishing a supernatural sanction for morals and an aristocratic state as the agency by which his teachings, thus supported, were to be imposed upon humanity. In Aristotle's time these motives had already found expression in the famous transcendental theory according to which the ultimate reality was an incorporeal world of subsistent Ideas apart from the world of appearances, perceptible phenomena being merely the distorted images of this reality and worthy of study only for the suggestions they conveyed to the imprisoned souls of men of the final Truth and eternally dominant Good which in their free immortal state these souls had known by immediate intuition.

The Academy, when Aristotle entered it, was no longer engaged in discussing the ethical and religious import of this theory, but was attempting the more difficult task of giving it clear conceptual definition. Discussion among the younger members of the school was eager, lively and doubtless keenly dialectical. It would not be a bad guess to ascribe the logical trend of Aristotle's later thought primarily to this stimulation. What else he gained from it can only be inferred from the content of Plato's later treatises. The first of these, the *Theaetetus*, shows clearly that its author had already found in the abstract concepts of mathematics a clue to the more subtle definition of the Ideas. Mathematics, then, was becoming increasingly important in the discipline of the school; but Academic interest in it was metaphysical, and appears to have contributed little or nothing of significance to its development. The great geometers of the time lived and worked elsewhere, as had their predecessors: Archytas at Tarentum in Italy, and Eudoxus of Cnidus, the outstanding scientific genius of the age, at Cyzicus. There Eudoxus had established a scientific school the activity of which profoundly influenced the Academy, who assimilated what they deemed important of its discoveries, just as they had assimilated those of the now dispersed Pythagoreans.

From certain refugees of this strange brotherhood, who had developed the first systematic mathematics out of their quasi-Orphic religious rites of purification, Socrates had already borrowed a not inconsiderable amount of mystical doctrine; and Plato, following him, was fascinated by it. His poetical temper, which responded so spontaneously to the elusive suggestions of ancient myth and legend, found

not only in these but also in the Pythagorean numerology a vague significance which appeared to him profound; and at this time, the new knowledge of Babylonian astralism which the widely-travelled Eudoxus had brought to Greece accentuated this wondering interest in things mysterious. Plato's later work in this manner became even more deeply tinged with mysticism, and toward the end verged strongly toward the occult. His theory of Ideas, originally the imaginative product of a moral aspiration, but now rationalized, excepting for its Orphic and Pythagorean content, as an idealistic representation of the world of ultimate reality, became more definitely religious. With its further syncretic development, Chaldean astrology appeared for the first time as an element in Greek speculative thought; the descriptive names of the planets were replaced by the names of those Hellenic deities which most closely resembled the Babylonian; Zoroastrian elements entered to accentuate its blending of morals with the worship of the heavens, and so on—until finally its metamorphosis into a system of dogmatic beliefs was complete. This stage of Plato's thought is best represented by the *Timaeus*, an indefinite and poetically suggestive work which scholars have struggled for centuries and still struggle to interpret rationally, and by the *Laws* in which, among many expressions of arbitrary intolerance, he condemns as atheistical and punishable by death all those who still venture to study astronomy otherwise than in his own manner as an orthodox religion.

The younger generation in Plato's school did not accept all this, and it seems that not a few of them were becoming destructively critical of certain tenets of his theory even at the time when he wrote the *Parmenides*, though all of them, probably, subscribed to his fundamental doctrine. Among these was Aristotle. He remained at the Academy for twenty years; wrote dialogues of literary excellence in the later didactic manner of his master, and meanwhile, though still under the compelling influence of Plato's personality, gradually developed his own ideas. But, so far as we know, he wrote nothing in contravention of the school's accepted teachings before Plato died. For three hundred years thereafter only his immediate followers knew his later treatises; for shortly after his own death these disappeared, and were rescued from oblivion only when Andronicus of Rhodes recovered them in the time of Cicero. Aristotle's ancient reputation, therefore, was that of a disciple of Plato; and his dialogues were accepted by the Neoplatonists themselves as pure Platonic doctrine.

When Plato died Aristotle left Athens, and lived for a few years in

association with his friend Hermias, the tyrant of Atarneus in Asian Aeolia, lecturing, either occasionally or regularly, in the school that had been founded at Assos under this ruler's protection. Then, having accepted an invitation from Philip of Macedonia to become his diplomatic adviser and the tutor of his son, the young Alexander, he spent another few years at the Macedonian court. These independent occupations, in part philosophical, in part political, occupied the next twelve years, which were the most productive of his life. It was during this time that he first formulated the principles of his own philosophy, and broke away from the intellectual tradition of the Academy, giving up the opinions that formerly held him, gladly, as Plutarch says, because he considered this a necessary sacrifice to the truth.

The dialogues written during his last preceding years in Athens, though they lack completely the allusive indefiniteness and mystical obscurity of Plato's writings, emphasize a demand for exactitude in scientific thought and give expression to that love of nature which he seems never to have lost, still assert the primacy and sufficiency of a purely theoretical knowledge, such as is revealed only to the creative intellect that reflects upon immaterial being alone and which discovers thus and contemplates only what is perfect, changeless and eternal in nature; and they reiterate the belief that the human soul, immortal though imprisoned in the corruptible flesh, is part of this divinity, and advocate a rigorously ascetic code of morals which recognizes the utter worthlessness of earthly things.

Such is the tone of the Aristotle of the Academy as he is revealed to us in the extant fragments of his dialogues. That shown in a later short treatise entitled *On Philosophy*, which Jaeger assigns to his very earliest years at Assos, is strikingly different. In this work, which appears to be a statement written expressly to define his first departure from the Platonic doctrines, his whole mental attitude appears to be changed. The religious feeling remains; its object, however, is no longer the imperceptible world of eternal Forms, but the living world of nature. Cicero quotes from it the following eloquent passage:

> If there were men who had always lived beneath the earth in good and shining habitations, adorned with statues and pictures and supplied with all the things possessed in abundance by those who are considered happy, and if, however, they had never gone out above the earth, but had heard by rumour and report that there is a certain divine presence and power, and then if at some time the gorges of the earth were opened and they were able to escape out of those hidden places and to come forth into these regions which we inhabit, then, when they suddenly saw the earth and the seas and the sky, when they had learnt the greatness of the clouds and the power of the winds, when they had gazed on the sun and recognized his greatness

and beauty and the efficacy with which he causes day by spreading his light through the whole sky, when moreover, night having darkened the lands, they perceived the whole sky laid out and adorned with stars, and the variety of the lights of the moon, now waxing now waning, and the risings and settings of them all and their courses ratified and immutable to all eternity—when they saw this they would straightway think that there are gods and that these are the mighty works of gods.

Evidently enough, it was no ascetic transcendentalist who wrote these words: They are those of a man who is wholly alive, and alert to the beauty and wonder of the sensible world about him—the Ionian naturalist come to life again. Even his discussion of theory has this background: it is historical; successive philosophical ideas are presented, as well as may be chronologically, as phases of a continuous development; and the treatment of religion is the same. This natural history of thought—the first ever written—is followed by a destructive criticism of the theory of Ideas. Aristotle's original arguments are not preserved, but, being of necessity logical, are not improbably the same as those of the first book of the *Metaphysics*, which was written, according to Jaeger, at this time or very little later. These show that the Ideas are wholly gratuitous, that their existence would imply an infinite regress of like ideas-of-ideas, that whenever their nature is defined they become mutually inconsistent, that the notion of a *participation* of phenomena in the Ideas is meaningless, and that the latter, being changeless, offer no explanation whatever of the processes of nature; from all of which he concludes that they are mere words. It is the physical world itself, he says, which is eternal; a world of things in process of change, being continually generated and destroyed, but in definable ways which produce, disintegrate and reproduce, endlessly, the same forms out of an indefinite material substratum; forms which exhibit such similarities that they can be classified by types and groups of types increasingly inclusive but always definable by abstraction. It is this very corporeality, this endless series of recurring forms—shapes and lustres, densities, odors, viscosities, tones and colors, these specific potencies which always yield the same substances by like processes of growth and transmutation, and these sharply definable relations between bodies that are characterized by such attributes, which permit their grouping by classes in generic order—it is these elements of experience that constitute the eternal and changeless. For, whether they are masses, or potencies or qualities, or species and genera, and though their distribution perpetually changes, *as such* they are always the same, and occur in the same associations. They are incorporeal and universal, that is to say,

they are ideas; but they do not exist apart from the physical world; they are, on the contrary, in it and of it; and further, since this is so, they become known, not at all by some reminiscent illumination of the immortal soul, but by observation and study of the actual world, as general concepts which define its underlying structure and order.

This minimal amount of Aristotle's final First Principles may confidently be assigned to the period of his treatise *On Philosophy*. Whether or not it was further developed at this time does not matter; for the basic conceptions of his final philosophic doctrine are here presented. It is evident that together they signify, not a modification, revision and development of the ideas of Plato, but their unequivocal repudiation.

It is still contended, and with justice, that Aristotle's recognition that all knowledge is conceptual, the terms necessary in any reasoning whatever being abstract and general, is due to his training in the Academy, where all discussion concerned itself not ingenuously with the nature of things without reference to the process of knowing, but rather, introspectively and self-consciously, with ideas. But this was the character of all critical thought from the time of the sophists down. Aristotle himself acknowledged his debt to Socrates by saying that two things in fairness must be ascribed to him, inductive arguments (about the meanings of terms) and universal definition. The school of Plato had developed this analysis, and brought clearly to light the fact that general concepts, in contrast with the changing world to which they originally referred, were changeless forms of thought; but hypnotized by this idea just as the Pythagoreans before them had been hyponotized by the idea of changeless number, and the Eleatics by the idea of the Absolute, and infected with the mysticism of these older schools which Socrates had transmitted, they shared his complete indifference to natural philosophy, forgot that the changeless entities on which they meditated were ideas conceived by the human mind, sought no generating cause behind them and instead of developing a rational epistemology pronounced them absolute.

Without further reference to the vagaries of mystical thought to which this dogmatism led, it is easy to see why Aristotle rejected it. His spontaneous love of the world of nature, which animates the striking passage I have just quoted, forbade him to accept as valid any theory of reality which could not explain its incessant change, and which ignored the immanent power within it—the compulsion of

fact, which obviously determines both will and waking thought. In addition, his genetic habit of thinking, which may, perhaps, be traced to that particular interest in living nature which was the interest of his ancestors, compelled him tirelessly to seek out causes for everything, and to rest dissatisfied with any doctrine which left anything causeless save the totality of Being. He thus discovered the generating cause of the ideas in perceptions of the natural world, remembered, compared, discriminated, generalized and arranged in generic order; and thus outlined the first psychological epistemology, that which refers all knowledge to physical experience. This is made evident in the first paragraph of the *Metaphysics*, from which I shall presently quote. And finally, his treatment of the Ideas shows even more clearly that to his logical mind, the keenest that had yet appeared in the world, the Platonic conceptions were altogether too incoherent and by implication too absurd to be credible even as reasoned dogma. I must emphasize this point. Without reference to his own theory of the nature of things, and by logic so pure that even the purest rationalist could find no flaw in it, he utterly destroyed the Platonic theory. If its like survives today this can only be by grace of an act of faith.

In its place Aristotle erected a structure of general conceptions, explicitly derived from sensory experience of the physical world. I venture to say that no mutation in the whole history of philosophy—save that of its very origin in ancient Ionia—was so uncompromisingly abrupt and complete. What, now, was the final character of this new philosophy of nature? Already we have surveyed its basic conceptions. Time presses, and gives no opportunity for discussion of its subtle elaboration and of the arguments adduced to support it; but this is not necessary. Its elaboration is largely a minute analysis intended to make its postulates and the logical consistency of its derived conceptions unequivocally clear; its arguments are those presented to contemporary philosophers, principally Platonists, who are met usually on their own ground. The analysis is minute beyond all present necessity, the arguments are equally wearisome and their purport not infrequently obscure excepting to one fully versed in the conflict of opinion in Aristotle's own day. I wish, however, to call attention to certain points that would be of particular interest to a scientist whose curiosity might lead him to ask how far this ancient thinker advanced toward that view of the world, familiar to us, which is the actual outcome of the philosophical empiricism he sought to establish.

Everything essential to this inquiry will be found in the final text of

the *Metaphysics*,—which is a late compilation of lecture briefs and texts, in large part written at the time of his treatise *On Philosophy* but amended and amplified in his later years—and almost enough for the purpose will be found in its fourth book, called *Gamma*.

The very first words of this treatise state, simply, both its purpose and the predisposition of its author. "All men," says Aristotle, "by nature desire to know. An indication of this is the delight we take in our senses; for even apart from their usefulness they are loved for themselves. . . . By nature animals are born with the faculty of sensation, and from sensation memory is produced in some of them. . . . The animals other than men live by appearances and memories and have but little of connected experience. . . . But in men, from memory experience is produced; for many memories of the same thing produce finally the capacity for a single experience. . . . And art arises when from many notions gained by experience one universal judgment about a class of objects is produced."

This is the utterance of a man who not only wishes to know, but asks immediately how we know; and answers the question briefly by sketching the natural process of knowing in fewest words as if it were a matter commonly understood. There is not here—nor, indeed, elsewhere—any suggestion of the possibility of knowledge derived otherwise than by inductive inference from experience of the natural world. This world Aristotle recognizes as independent of and prior to the act of knowing, just as we do, and for the same reason,—namely, that it is a world of necessity in which compulsions constrain both will and thought; and he says further that "it is impossible that the substrata which cause sensation should not exist even apart from the sensation. For sensation," he says, "is surely not the sensation of itself; but there is something beyond the sensation which must be prior to it, since that which moves is prior to that which is moved. . . ." Not only, therefore, do we derive our knowledge from experience: the character of our knowledge is predetermined by natural necessity. Consequently, with respect to its sensory foundation at any rate, it is true knowledge: a direct reflection of fact. "For," he says, "it is not possible to be in error with respect to the question as to what a thing is save in a accidental sense," that is, by inconsistent identifications due to ignorance of attendant circumstances and consequently erratic inference, which further and more extensive observation will correct. Against the sceptics who emphasized the diversity of different individual sensory impressions of the same thing, and insisted that a choice between the conflicting ideas derived from such impressions

must be arbitrary, he argued that "the truth is not that what appears exists, but that what appears exists *for him to whom* it appears, and *when* and *in the sense in which* and *in the way in which* it appears." Here is an admission of the relativity of knowledge; but a denial of its indeterminacy, since its relativity is defined as the mutual interdependence of impressions. Know the whole *Gestalt*, and you know truly.

It is but a step from this position, in the direction of Aristotle's own genetic tendency of thought, to admit, in recognition of the incompleteness of our knowledge, the necessarily tentative character of all conceptual representations; but Aristotle will not go this far, for reasons that will appear. He knows, like everybody else, that we do possess a store of perfectly dependable knowledge derived from the correlation of diverse impressions which within human experience is final: in a word, that we know a multiplicity of undoubted facts, some of them of inclusive generality. He expressly postulates, therefore the possibility of a similar positive knowledge of everything, by asserting *a priori* the minimal necessary assumption, which is that a thing cannot be and not be in the same sense at the same time. This postulate, called the law of contradiction by logicians, might equally well be called, by one more interested in the theory of knowledge, the law of exclusive discrimination; for it is derived from the conviction that things can be unequivocally identified. He justifies it, conclusively enough, by the observation that to reason at all we must start with postulates of some sort, since otherwise our thought would be involved in an infinite regress of conceptions; and remarks that no postulate could be more simple than this one, which is, furthermore, consistent with all experience. He challenges the sceptics to dispute it, and promises to entangle them in hopeless confusion of thought if only they will say *something* and not take refuge in silence, expressing their doubt, as Cratylus was forced to do, by merely wiggling their fingers.

We are all familiar with the general outlines of the conceptual structure that he builds on this foundation: that of a finite corporeal world which is continuous—for there is something everywhere even if it is no more than warmth and cold or the movement of the aether which men call light—and yet heterogeneous, separated into parts distinguishable by different attributes. These distinguishable somethings (or, more briefly, things), which Aristotle calls *substances*, are generated and destroyed, come to be and pass away; but while they exist, there is that in each of them which, quite apart from those

accidental attributes that may occasionally and indiscriminately affect them, is always the same,—persists,—remains unchanged; which upon its regeneration reappears unchanged; which, indeed, continuously exists unchanged as its incorporeal *essence*, the object of pure conception.

There still attaches to the word essence—thanks to the persistent bad habit of many scholars who continue to think about Aristotle in Latin—a not inconsiderable flavor of the occult. It is worth while, therefore, to remark concerning this word (one among several in the translated Aristotelian vocabulary which are similarly affected) that the suggestion of transcendental mystery it conveys is quite gratuitous. This we realize at once when we say instead that this suggestion of mystery is not *essential*. There is nothing mystical about these essences: they are simply physical properties or, in Aristotelian terminology, *forms* which uniquely characterize different kinds of substances, and thus define them. They are, of course, not tangible things but concepts—which, when they refer to substances, are qualifying attributes expressed by adjectives such as combustible, univalent, triclinic, vertebrate, parasitic; and when they are made the abstract objects of discussion become substantive and are expressed by nouns such as combustibility, univalence, triclinicity, backbonyness, parasitism. Further illustrations of this sort will make it quite clear that the mystery of the world of essence is merely the product of a naïve confusion of thought precisely like that which is nowadays evident in the ingenuous or whimsical imaginings of those who try to picture a burglar entering a bank-vault through the fourth dimension. Those who are familiar with alchemical theory will recognize the same sort of confusion in the thought of those sooty spagyrists who attempted to manipulate the three alchemical essences or Principles, their philosophical mercury, sulphur and salt—which were fluid metallicity, combustibility and vitriosity—as if they were corporeal things.

No such confusion affects the thought of Aristotle. He perceives, simply, that by their physical properties, or essences, all substances may be unequivocally discriminated and compared, and identified as individuals of definite *species*, or substances of a second conceptual order, which chemists who think of copper and caustic soda and sucrose call substances, without qualification, but which biologists who think of chimpanzees and roses and pneumococci still call species. These species, thus defined by their essences (and not otherwise truly defined), are now seen to fall into natural classes themselves definable by that which is common to particular groups of essences, namely

the essence of a more inclusive *genus*. The biologist still finds it convenient, if not necessary, to identify the multifarious species of animals and plants with reference to these genera, as *homo sapiens*, *drosophila melanogaster*, *solanum tuberosum*, and so on; and chemists do likewise, though more confusedly, when they speak of *potassium cyanide* or *diparaamidothiodiphenylamine*. And the genera may likewise be grouped in successive classes of higher order. Note that all these classes are real, but incorporeal and definable only diagrammatically or symbolically, that is, by abstract ideas which are essences and that they persist, though individual organisms die and compounds are transformed.

This is enough to illustrate the grosser outlines of Aristotle's envisagement of the natural order. The Academics before him had taken the first steps toward such classification, but their taxonomy was confined to the futile arrangement of pure ideas as such. It was Aristotle who first discerned this generic type of relation among things perceived, recognized its universality, realized its significance as the basis of all knowledge, and pointed out the possibility of its development to extreme exactitude by increasingly minute and discriminating observation. He developed its implications subtly and elaborately, and identified it with the order of deductive thought. Species and genera, once determined by observation and inductive inference, typified in their complicated relations the relations of all ideas. The *syllogism* is nothing other than the statement of the simplest generic relation:

> The individual Socrates is of the species man.
> The species man is of the genus mortal being.
> Therefore Socrates is of this genus and is mortal.

In the *Analytica* he reduced the most complicated of deductive processes to this simple type, the "first figure of the syllogism." J. S. Mill properly criticised this sort of reasoning as circular, since all general premises presuppose a knowledge which the conclusion merely makes explicit. I hardly think that Aristotle would have disputed this: but he might well have pointed out that latent knowledge is merely potential, and does not become actual until it is made explicit: there are very few of us who can determine by mere inspection the real roots of a cubic equation. He developed no fixed method of inductive logic, for the simple reason that there can be no such thing; since, as he knew, the process is one of observation and comparison, and effective procedures in this sort of thinking are many.

Aristotle does not, in his theoretical works, actually apply this scheme of thought, and so develop it. He does, however, call attention to the several aspects of phenomena with reference to which, inevitably, they are described and become by conceptual definition known. These are the *Categories:* we might call them conditions of actual existence. They are also ways of knowing and primary forms of assertion. To know a thing we must know where it is, when it occurs, how it affects our senses, how much it is, how it acts or is affected by action, and what its relations are to other things; or, to use the customary formula, we must know it as Substance, and with reference to Space, Time, Quality, Quantity, Activity, Passivity and Relation. These categories overlap, but they are exhaustive.

In physics today we have reduced their number—sometimes uniting Space and Time in a four-dimensional continuum, considering time (if I may be forgiven) an imaginary distance; wholly eliminating Passivity by the law of action and reaction; and determining Quality by measurement, thus representing it by, if not actually reducing it to Quantity. But these are all theoretical innovations, the philosophical import of which appears not to be settled yet. There are those who still believe that there is something essentially different in Space and Time: that being large and being old are not in any sense the same; though growing up and growing old are related, being different aspects of a single process of change; and Aristotle himself said that all change involves and may be determined by motion in space (a pregnant remark!) from which motion, he also said, we derive the conceptions of space and time. In practise, further, we are still compelled to define many passivities, without reference to specific reacting forces, as hardness or elasticity or breaking strength, and so on. The definition of qualities by quantitative measurements, finally, is not yet universal, and if compulsory would be sometimes very awkward in chemical, biological, and other scientific practise. In short, when we alter these categories we depart from the actual sensory world which Aristotle studied and which remains the only complete reality; our conceptual representations being, in fact, diagrammatic and imperfectly so at best.

Now, all this representation of substances, essences, species, genera and logical categories refers only to the permanent structure of the world—or rather, to its structural plan, which is the same as that of our reflective thought. But Aristotle was interested, and intensely so, in the phenomena of change: of movement, generation and corruption,

material transformation. Beneath all his detailed criticism of the theories of his predecessors there frequently appears the fundamental objection that they are defective in not attempting to explain occurrences as well as things. This, he observes, is the primary defect of the whole Pythagorean-Eleatic-Platonic complex of doctrines. Those of other philosophers, notably Heraclitus and the Atomists, show deeper insight, for they are dynamic. Even in them, however, theory remains inadequate in not taking into account the actually determinate character of all processes of change. Heraclitus' conceptions of cyclic process and dynamic equilibrium are incidental features in a theory of universal flux, whereas actual changes—if we except the motion of the stars—have beginning and end in fixed substantial forms: water changes to air, bog-ore to iron, acorn to oak. The doctrine of the Atomists is even less acceptable; for the random motion they imagine would produce not a limited but an infinite number of types of change, which is contrary to fact, and this with no regularity of process, which is again contrary to fact.

To meet these objections, Aristotle proposes his *four causes*, which may be thought of as analogous to the categories in that they refer to the determining conditions of all change, these being at the same time necessary inferences from the phenomena—aspects of nature again—and also ways of knowing. There must be something to change —a material cause; an action or potency to start it—an efficient cause; a necessity which makes it follow a definite course always the same in similar circumstances—a formal cause; and finally a purpose, defined by its end—a final cause. The material cause is matter, Aristotle's indeterminate substratum actually existent only in substances, which we quantify as mass; the efficient cause we call energy,—mechanical, chemical or vital; the formal cause, natural law. The final cause we ignore in science, not because there is no purpose in nature, for there is purpose in nature, at least in men and higher animals; but because it does not assist us to understand phenomena. To Aristotle, however, the phenomena of life, in which he was most intensely interested, were inexplicable without it: he had to include it, or leave his own system in one aspect defective like the others. Also, the reasonableness which all Greeks from first to last imagined as latent in nature, that immanent intelligibility which accounted for the possibility of understanding, was doubtless very vivid to the thinker who had discovered the exact correspondence of the forms of nature and the forms of thought, and worked to the same end. He conceived all nature, therefore, as

purposeful, and thought of formal causes as evidences of intelligent guidance determined by the final cause of all—a divine intention, not supernatural but, like the physical world which was its embodiment, eternal. This was his *entelechy*. His system, unlike our own, was teleological; and like those that preceded it culminated in a conception that we call extra-scientific, that is, the conception of the divine. In this sense it became a theology: Aristotle himself gave his First Philosophy this alternative title.

This introduces us to that part of the philosophy we are considering upon which the interest of metaphysicians is still focused. Jaeger himself devotes the greater part of his criticism to the development of Aristotle's theological doctrine; not only because of its historical importance, I think, but also because it still appears to him, as a philosopher, the most important aspect of his great predecessor's thought. You will not blame this distinguished scholar for any of the tedium you may have felt during the preceding discussion: its familiar matter he doesn't mention at all, not even to refer to its scientific implications.

What, then, is this theology? Let me, first of all, refer once more to the text of the *Metaphysics*, in order to make clear its philosophical basis, which, as I have already indicated, is the general conception there presented of the world of nature. The first step toward a consideration of the transcendental is taken when we meditate upon the most general of all ideas, that of existence. What, then, transcends this world of nature and its reflection in reason? In the most comprehensive meaning of the words, What *is*? At this point Aristotle's meditation carries him to what will at first seem, even to a scientist, a radical empirical extreme. He answers, in effect —"Nothing transcends the world of nature; indeed there *is* nothing, really, but what is *known*." In short, he identifies that which is with that which is known; which means for him, we must remember, known exclusively through experience. There is always the possibility of new experience: the natural world has this potency. But Aristotle means by potency exactly what we do when we refer to gravitational or thermodynamic potential or potential energy in general: not a mystical pervasive complex of indeterminate influences, the primitive *Mana*, a participative feeling of which is the beginning of religion, but merely a blanket term which designates a number of specific potentials (let us say), each definable by its actual effect. Aristotle criticises sharply a philosopher

he rather admires, Anaxagoras of Clazomene, for ascribing the origin of things to an indeterminate mixture. There is no such thing, he argues, because it cannot be defined. Nothing really *is* but the content of knowledge; for the word "is" has no meaning unless it refers to something: no predication can be made about the unknown. Things may come into being; but before they are known they *are* not, and can be said to be possible only by inference from an actual event.

We might try to amend this statement by saying that all this is so, but only so far as we are concerned; that other animals with senses different from ours may know things not known to us, which are therefore actual to them; and that we all, including Aristotle himself, believe that the world existed before there were any human beings to know it. But note that these statements all express possibilities only: it cannot be categorically asserted that animals do know what is unknown to us, much less what they know, until we are able to infer from our own knowledge of their behavior that they do perceive directly something (like sounds of high pitch or odors) which we perceive otherwise, or from other knowledge infer to be existent. Then we may assert not only that they do sense what we cannot, but that they did formerly sense what we could not. In the same way we may assert that the earth existed before there were human beings to know it, but only after we can infer from a mass of present knowledge that this must have been so; and then, this fact is a part of knowledge. When we speak of Being, says Aristotle, we mean the known; all else is not-Being.

Note that this not-Being includes all that is indeterminate in any way: space unoccupied or unbounded by substance; or, in any sense whatever, the infinite, since only the finite is actual; or potency not specifically designated by some actual effect; or matter deprived of form,—that is, substance without attributes—but not pure form, for this, though incorporeal, may be conceived with reference to the actual—not only as some common abstract idea, but as figure and number, arithmetic form, type of logical relation, or mode of behavior. In short, anything definable may exist; but nothing indefinable, for the indefinite cannot be thought about, excepting by negation.

Aristotle's final theology is consistent with these premises. Jaeger describes its development most interestingly, at length; our own divergent interest permits us to summarize his findings briefly. In the treatise *On Philosophy*, referring to religious rituals, Aristotle says: "Those who are being initiated are not required to grasp any-

thing with the understanding (*μαθεῖν*), but to have a certain inner experience (*παθεῖν*), and so to be put into a particular frame of mind, presuming that they aré capable of this frame of mind in the first place." He thus sharply separates the religious from the theoretical interest; and his theology becomes a part of his physics, the superstructure of his theory of nature, or, as our ancestors expressed it, "the Queen of the Sciences"—in a word, a natural theology.

To find his evidences of the divine he contemplates the heavens, like the old Pythagoreans and like multitudes of other men, before and after. Up there, the changeless stars at immeasurable distances move eternally in their circular courses, measuring endless time. This motion is natural to the heavens and proves them to be of other substance than any we know in this thick vapor which surrounds us on Mother Earth, where everything when unconstrained moves up or down. The purer air above us becomes transformed beyond the moon, where only the purest exhalations penetrate; it becomes celestial aether, an essence *sui generis*. Within these silent realms all movement is spontaneous, for here it originates: the stars are living beings, therefore, of purest substance, nourished by the finest exhalations; and since this is so, their conscious minds are more intelligent than it is possible for us to conceive; for did not Hippocrates show that the purest foods and airs and waters produce in men the finest minds? The stars' spontaneous movements, however, are all the same, and even the wandering planets below them share in their ceaseless daily revolution. This proves the presence in the furthest celestial realm of a single Potency that guides them all: a first cause of movement, itself quiescent Form; the divine Essence, which is God. Not the Creator, for the cosmos is uncreated, eternal: not the Idea of the Good, unless one sees supreme good in supreme intelligence and the perfection of its actualization in celestial movement; for there is no Providence in Aristotle's heaven, only power. His God is the divine potential energy that animates the world.

In the twelfth book of the *Metaphysics*, called *Lambda*, Aristotle develops these conceptions and defends them by arguments to prove the actuality of the divine in nature; that is to say, the existence of God as thus conceived. Of this book, the first seven chapters are coherent doctrine; but the eighth, which superimposes fresh arguments that are clearly intended to clarify the preceding by a more minute analysis of the phenomena, introduces in so doing remarkable inconsistencies and corresponding doubt, as if the scientist were driven by

force of detailed evidence to question his prior conclusions and reconstruct his theory. Jaeger shows that the coherent books are old, dating from the period of the treatise *On Philosophy*, but that the eighth is much later, the product of further studies finally matured. Its reconsideration of the earlier doctrine is based on the mathematical analysis of celestial motions made by Eudoxus, from which this astronomer deduced the first purely scientific planetary theory—the system of homocentric spheres which Aristotle had accepted as the basis of his own physical cosmology. This showed that although all planetary movements could be conceived as if they were the resultants of uniform circular revolutions variously compounded, each one of these composite movements was peculiar; and Aristotle found himself unable to account for their striking differences by the assumption of a single physically definable cause. In the terms of his doctrine this meant that the question was left open as to whether the primary potency, the divine essence, were one or many; in short, whether or not it was possible to infer from the phenomena the presence of one Omnipotent God.

Thus Aristotle's natural theology broke down. Confessing failure, he abandoned it, leaving to his successors, in place of a definitive theology, an unsolved problem. His last words upon the matter imply a mood which closely approaches to agnosticism. He writes, referring to his own physical model of the cosmos: "Let this, then, be taken as the number of the spheres (the carrying spheres of the planets), so that the unmovable substances and principles may probably be taken as just so many: the assertion of necessity must be left to more powerful thinkers." And again in the *Physics:* "Motion, then, being natural, the first mover, if there is but one, will be eternal also; if there are more than one, there will be a plurality of such movers. We ought, however, to suppose that there is one rather than many, and a finite rather than an infinite number . . . and in this case it is sufficient to assume only one mover." This expresses his final attitude toward the problem. The question is open; but for methodical reasons, and in accord with the principle of parsimony, it will be better to assume one ultimate essence.

These statements do not at all suggest the temper which we associate with theology. In Aristotle's thought religious feeling is completely dissociated from his theory of the cosmos; he clings instinctively to a monistic view of the world as the most of us do today; but perceives, as frequently we do not, that this view is not a neces-

sary inference from phenomena, but a postulate, which is to be justified on methodical, that is to say, on pragmatic, grounds. I think you will agree with me that this final doctrine looks much more like theoretical physics than anything else. A man of science is inclined to wonder why, even in its original form, it was ever called by Christians a theology. In reality this was an historical accident: a falsification of its original tone, due to the reintroduction by scholastic commentators of that religious feeling which Aristotle had excluded from it. The God he conceived,—a universal Potency actualized in celestial motion, the pure Form that defines the nature of cosmic Power—what would this have been if a miracle had revealed it to his searching thought? Would it not have been what it is to us: the Form, or as we say, the Law, of Universal Gravitation?

The critical revision of Aristotle's theoretical works, which produced the final texts of the *Physica*, the *Metaphysica*, the *Analytica*, the *de Caelo* and the *De Generatione et Corruptione*, was made after Alexander succeeded to the throne of Macedonia, and left the philosopher free to return to Athens, there to organize his own philosophical school, the Lyceum. Perhaps the most significant result of Jaeger's critical work is his definitive reconstruction of this establishment. It was not at all a school of philosophy of the familiar Greek type, but something entirely new: an institute of scientific research, where students assembled, not to sharpen their wits and stimulate their creative thought by lively dialectical disputation about the nature of things in general, but instead to listen to formal lectures: some on the biology and medicine of the day, illustrated by specimens of animals and plants, anatomical charts and similar demonstrative apparatus; some on meteorology or geography, or the history of events; others on mathematics, theoretical music and astronomy, or on the critical history of philosophy. Thus the natural sciences were taught each as a particular discipline and were coördinated by historical and critical studies. This education led directly to the prosecution of specialized research by those whose taste and aptitude encouraged it, each in a chosen field, and made possible certain coöperative investigations in historical and biological studies directed by Aristotle himself.

From the beginning, the new work undertaken by the school was exclusively scientific. Aristotle himself, with the probable assistance of his students, then wrote those works that mark the beginning of

scientific scholarship—the histories, based on records and inscriptions, which include his encyclopaedic survey of the constitutions of the Greek city states. Then also he compiled the *Historia Animalium*, and wrote his extensive treatises on the gross anatomy, the movements and the reproduction of animals, and on physiological psychology, together with many shorter monographs on particular biological phenomena. In consideration of the fact, which Aristotle himself asks us to remember, that this was the first work ever done in comparative biology, its results are admirable: its method is altogether predominantly inductive, its findings being based not so much on the evidence of common report as on the results of patient and careful observations, in part experimental and frequently remarkably accurate; and its critical tone, particularly in the discussion of prevalent beliefs concerning dreams, divination, prophecy and so on, is wholesomely sceptical. This work marks the dominance of the philosopher's maturest thought by unequivocally scientific interests, and is convincing evidence of his ability in scientific research, even when this is unfairly judged by present standards. His critical syntheses of work in other fields is based, of necessity, on the findings of others, and only too frequently reflects the ignorance of his time, especially in mechanics, where it is developed (probably in greater part by his successors) from reasonable but untested and erratic premises. Such defects, however, whenever the works in which they occur may be considered his own, are obviously to be attributed not to a persistent predilection for *a priori* reasoning quite inconsistent with the whole character of his later writings, but rather to the impossibility that one man could check the data in all fields of research.

It seems to me, moreover, that, important as these investigations were, they are of less significance as contributions to knowledge than as evidence of the complete emancipation of critically philosophical thought at the beginning of the Alexandrian Age from the insidious influence of those mystical vagaries which, through the teachings of the Academy, had threatened and very nearly accomplished the total extinction of Greek natural science. That this calamity was averted was due to the unaided effort of a single great man whose penetrating acumen and conceptual grasp and whose uncompromising intellectual integrity were powerful enough not only to disencumber his own mind of these hypnotic influences, even against the persuasions of a venerated teacher reiterated during twenty years, but to turn the whole tide of philosophical inquiry back again through the original channel

of its flood to the disinterested investigation of nature. The achievement was magnificent.

But Aristotle not only turned the tide: by the organization of his school he ensured its continued flow. After him, his friend and successor Theophrastus, criticizing destructively the metaphysical superstructure of his earlier philosophy, pronounced all theology transcendental and excluded it from scientific consideration; in the next generation Strato of Lampsacus likewise discarded the conception of final cause. A multitude of scientific works, inspired by the spirit of the master's own researches, were produced by the school: the critical history of philosophy of Theophrastus, the history of mathematics of Eudemus, the botany of Theophrastus and his work on minerals, the theoretical music of Aristoxenus, the geography of Dicaearchus, and many others. It is often remarked that the Peripatetic school produced no men of great talent after Strato. This, I think, means that it produced no speculative philosophers of distinction; and this is true. But if its influence on the progress of thought be thus incautiously estimated, the judgment is quite fallacious. Those who inherited the Peripatetic tradition and practised its methods were not philosophers, but scientists—it was the school itself which established this distinction—and among them were many of the very greatest thinkers of antiquity.

The Alexandrian Age was the ancient Golden Age of Science. The empirical tendency of all Greek philosophy in the three centuries that followed Aristotle's death is a very striking fact, and its association with an increasingly sceptical spirit no less so. The Museum at Alexandria, founded by Ptolemy Philadelphus and organized in accordance with the sought advice of the Peripatetics Demetrius of Phalerum and Strato of Lampsacus, was something very like an enlarged Lyceum—another great institute of research. It became the most important center of that renewed intellectual stimulation which ultimately gave to the world the finest products of Greek scientific genius: the technology of Ctesibius and Hero, the mathematics of Archimedes and Apollonius; the astronomy of Aristarchus of Samos, Eratosthenes, Hipparchus and Ptolemy; the anatomy of Herophilus and Erasistratus—which came in part directly from that Metrodorus who had taught in the Lyceum—and the experimental physiology of Galen; the cultural anthropology of which we have fragments in the works of Callimachus; the history of Polybius and of the doxographers who handed down the Peripatetic history of science; the geography of

Strabo; the literary criticism of Aristarchus of Samothrace and other distinguished scholars who edited and preserved the ancient classics and standardized the Greek language; and the sceptical philosophy of Pyrrho, Carneades, Aenesidemus and Sextus Empiricus whose critical labors long perpetuated, even against the rising tide of supernaturalism which finally overwhelmed it, that methodical philosophy which, almost completely disregarded until our own time, we are forced to recognize as the explicit formulation of the principles of scientific judgment which we now universally—though not always consciously—accept as valid.

In the entire range of human experience up to the time of Kepler and Galileo there is no intellectual achievement that can bear comparison with this. Without doubt it was stimulated in particular ways—especially in mathematics and in medicine—by the work of Aristotle's predecessors: by the latter Pythagoreans and the school of Eudoxus, by the medical schools of Cos and Cnidus, and otherwise; and doubtless also it was encouraged by the practical spirit that universally characterized the early Alexandrian temper, and by the agnosticism that then prevailed among the intellectual classes. There is, however, the most conclusive evidence that no single influence affected it as significantly as that of the Peripatetic school, the school of Aristotle; which, guided by his undying spirit, determined the character, and fixed the intellectual standards of the most powerful educational establishments of the age.

Such was the work of Aristotle. Interpreted by the medieval scholastics and by their spiritual descendants among modern speculative philosophers—whose predispositions have naturally led them to value most highly the early philosophical conceptions that linked his thought with that of the greatest religious thinker of antiquity—he has become almost universally known as the father of transcendental metaphysics. But the labors of an acutely critical scholar, clarifying at last the history of his intellectual life, now leave no room for doubt that, judged by the final outcome of his thought and labor, he belongs not to the theologians but to us: the greatest of ancient metaphysicians who became in maturity the founder of critical natural philosophy, and of systematic scientific research.

BOTANY.—*Notes on the Myristicaceae of Amazonian Brazil, with descriptions of new species.* II.[1] ADOLPHO DUCKE. (Communicated by E. P. Killip.)

VIROLA Aubl.

Synopsis of the species (principally from Amazonian Brazil) according to the characters of the fruit and of the androecium.

A. Fruit densely covered with soft-velvety subpersistent hairs which are ramified in numerous short lateral spurs; pericarp rather thin.
   a. Length of these hairs up to 8–9 mm Anthers connate, commonly subobtuse at the apex, slightly longer than the androecium column. 1. *V. loretensis* A. C. Smith.
   b. Length of these hairs up to 3–4 mm Anthers free in terminal part, a little divergent at the apex, very much longer than the androecium column. 3. *V. divergens* n. sp.

The following probably should also be included in group A:
   c. 2. *V. mollissima* (A. DC.) Warb. Female plant unknown. Indumentum nearly like in *V. loretensis*? Anthers connate, very much longer than the androecium column. Leaves very large. Eastern Peru. Not seen.
   d. *V. urbaniana* Warb. Female plant unknown. Anthers like *V. divergens*, according to the description. Goyaz. Not seen.

B. Fruit covered with easily deciduous tomentum composed of very small (0.1–0.2 mm long) stellate hairs; pericarp thin. Anthers very much longer than the column, lineal or narrowed to the apex.
   a. Fruit ellipsoid, 11–16 mm long and 10–12 mm broad. Trees of upland forests and of "campos" woods. 4. *V. sebifera* Aubl., 5. *V. mocoa* (A. DC.) Warb., and 7. *V. rufula* Warb.
   b. Fruit almost globose, 7–12 mm in diameter. Tree of the periodically inundable forest. 9. *V. cuspidata* (Benth.) Warb.
   c. Fruit (according to Warburg) globose-ovoid, up to 27 mm long; not seen. Pozuzu (Peru). A male plant I found at Rio Purús (State of Amazonas, Brazil) belongs perhaps to this species. 6. *V. peruviana* (A. DC.) Warb.

C. Fruit with indument as in B, ellipsoid, 15–18 mm long, 12–14 mm broad, with thin pericarp. Anthers nearly as long as the column. Forest tree of the hylaea. 10. *V. venosa* (Benth.) Warb. The two species *V. sessilis* (A. DC.) Warb. and *V. subsessilis* (Benth.) Warb. are "campos" shrubs of central Brazil, remarkable for their very small size and for their sessile or subsessile leaves; their fruits are covered with a more or less deciduous tomentum. I have seen fruits of *V. subsessilis* (State of Bahia, *Zehntner* 516 = 3054); they are oblong-obovoid, 15–20 mm long and 8–9 mm thick; their pericarp is a little thick but hard, covered with very minute stellate hairs. The fruits of *V. sessilis* are, according to Warburg, subglobose.

D. Adult fruits glabrous, pericarp thick. Anthers as long as or shorter than the androecium column.
   a. The thinner but more rigid coriaceous pericarp keeps its original form when dry. Fruits more or less globose or ovate-ellipsoid.

[1] Notes on the Myristicaceae of Amazonian Brazil, with descriptions of new species. I. This JOURNAL 26: 213. 1936. Received February 15, 1936.

I. Fruits 15–22 mm thick. From Ceará to the Guianas and Lesser Antilles. 11. *V. surinamensis* (Rol.) Warb.

II. Fruits 20–35 mm thick. From Rio de Janeiro and Minas Geraës to Santa Catharina. *V. gardneri* (DC.) Warb. and *V. bicuhyba* (Schott) Warb.

b. The very thick but more fleshy pericarp twisted and wrinkled irregularly and roughly when dry. Fruits generally ellipsoid.

I. Fruits (of our specimens) 20–30 mm long. 12. *V. carinata* (Benth.) Warb.

II. Fruits 30–40 mm long. 13. *V. albidiflora* n. sp.

III. Fruits about 30 mm long. Male plant unknown. Northwestern Matto Grosso. Not seen. *V. elliptica* A. C. Smith.

IV. Species of the affinity of the three last, but the female plant is unknown. Eastern Peru. Not seen. *V. weberbaueri* Mgf.

E. Fruit densely hispid-velvet with persistent hairs (ramified in numerous short lateral spurs), ovate or obovate-ellipsoid, about 30 mm long and 20 mm broad, with hard and thick ligneous-coriaceous pericarp. Anthers shorter than the androecium column.

a. Length of hairs of fruits 0.5–1.5 mm 17. *V. multinervia* n. sp.

b. Length of these hairs 2–2.5 mm 18. *V. decorticans* n. sp.

c. 16. *V. multicostata* n. sp., 15. *V. crebrinervia* n. sp., 14. *V. minutiflora* n. sp., *V. rugulosa* Spruce ex Warb., and *V. mycetis* Pulle may belong in this group; the female plants are, however, unknown. I have not seen the two last species.

F. Fruits very minutely rugose, covered with a thin but persistent tomentum of microscopic stellate hairs, oblong or obovate-ellipsoid, 15–20 mm long, about 10 mm thick; pericarp rather hard. Anthers about as long as the column, or shorter. 19. *V. calophylla* Spruce and 20. *V. calophylloidea* Mgf.

G. Fruit unknown. Anthers shorter than the column. The aspect of this plant is very peculiar and shows no affinity with the other species. 21. *V. parvifolia* n. sp.

1. VIROLA LORETENSIS A. C. Smith, 1931, floriferous (*V. villosa* Ducke, 1932, fructiferous). A small tree, remarkable for its few ramified, hanging, flexuous, often elongate inflorescences (up to 30 cm when fructiferous), and for its partly long and rather woolly indument. The subglobose-ellipsoid fruits 2 cm long are densely velvety with soft, articulate and shortly spur-branched hairs, up to 8 or 9 mm long. This indument seems to be more or less deciduous after the fruits mature. The staminate flowers correspond rather to the section *Amblyanthera* of Warburg; the connate anthers have the apex slightly obtuse, their length (when completely developed) equaling or slightly exceeding that of the column. It grows in the inundable forest along the rivers and sometimes in very moist upland forests, in argillaceous soils. Its geographic area includes Amazonian Peru, where it was found near Iquitos by Killip and Smith, by Kuhlmann, and by myself, and the western-most region of the Brazilian Amazon (Lower Japurá and Lower Javary), where, in the service of the late Dr. Huber, I collected specimens which are now in the Pará Museum (Herb. Amaz. 6792 and 7419).

2. VIROLA MOLLISSIMA (A. DC.) Warb., of Eastern Peru, seems to be

allied to *V. loretensis*, but is easily distinguished by its very large leaves and by its anthers, which according to all authors are like those of the common *V. sebifera*. I have not yet found it.

3. **Virola divergens** Ducke, n. sp. Speciebus *V. sebifera* (in Amazoniae dimidio orientali communi) et *V. urbaniana* (mihi solum e descriptione nota) affinis. A prima differt: partibus omnibus aliquanto maioribus et robustioribus, indumento densiore et aliquanto longiore, antheris parte superiore non connatis subdivergentibus, fructibus maioribus et longe densissimeque rufovillosis; a secunda (fructu ignoto) differt praesertim bracteis parvis caducissimis. Arbor parva vel mediocris; folia vulgo 20–30 cm longa, in individuis masculis saepius angustiora quam in femineis, saepe magis oblonga et marginibus magis parallelis quam in specie *V. sebifera*; costae secundariae vulgo utrinque 15–22, ut venulae transversae subtus pilositate longiore densiore et saturatius rufa notatae; inflorescentiae utriusque sexus saepe longiores et ampliores quam in specie citata; androeceum breviter stipitatum antheris 3 parte superiore non connatis subdivergentibus apice acutis; fructus maturus brevissime pedicellatus, globosus vel ellipticoglobosus 2.5–3 cm diametro, undique pilis mollibus detergibilibus pulchre rufis vulgo 3–4.5 mm longis articulatis et brevissime spinuloso-ramosis densissime subvilloso-velutinus, pericarpio mediocriter tenui sat fragili, seminis arillodio purpureo a basi laciniato, testa distincte sulcata.

Habitat in silva primaria non inundabili circa Manáos, leg. A. Ducke: loco Estrada do Aleixo, florifera, arbor mascula 27-4-1932, Herb. Jard. Bot. Rio 24550, feminea 15-5-1932, Herb. Jard. Bot. Rio 24548; loco Estrada do Tarumá, fructifera, 2-12-1932, Herb. Jard. Bot. Rio 24549). Prope Porto Velho fluminis Madeira leg. J. G. Kuhlmann 8-9-1923 (arbor feminea flor., Herb. Jard. Bot. Rio 24547).

This species, when floriferous, may be mistaken for luxuriant and densely tomentose individuals of the common *V. sebifera;* the anthers are, however, free at their apex, as in the central Brazilian species *V. urbaniana* Warb. It may be at once distinguished by its fruits, which are densely covered with rather long, articulate and spur-branched silky hairs of a beautiful red brown. *V. loretensis* has the fruits rather similar but with much longer articulate hairs; in all other characters it is very different.

4. VIROLA SEBIFERA Aubl. This widely distributed species is common from the Guianas through the whole State of Pará to the State of Maranhão (Anil, near S. Luiz, Herb. Gen. Mus. Pará 517); it grows principally in secondary forest and in rather dry woods of the "campos" regions. In the State of Amazonas it is less frequent; I have not found it around Manáos. It is, however, mentioned by Warburg for the Solimões region (Tiffé, the ancient Ega) and for eastern Peru (Tarapoto). I think I must refer to this species a tree of the upland rain-forest of Seringal Iracema (Rio Acre, Territorio Acre), Herb. Jard. Bot. Rio 24551, the leaves of which are more membranous and less tomentose than in the typical form. The geographic area of *V. sebifera* includes the whole hylaea, the central part of Matto Grosso, the State of Goyaz, and the northern half of the State of São Paulo; I have seen herbarium specimens from all these regions.

5. VIROLA MOCOA (A. DC.) Warb. Our herbarium has now an excellent representation of this species, which is allied to *V. sebifera*. It differs only in its non-cordate leaves, which have more distant nerves and more dense and uniform indument beneath. The fruits are not different from those of *V. sebifera*, their form being only a little more subglobose; they have the same ferruginous deciduous tomentum of exceedingly small stellate hairs. The tree, according to the collector, attains no more than 8 meters. Our specimens come from the type locality: Yurimaguas, Eastern Peru, Herb. Jard. Bot. Rio 23688 (male) and 24546 (female tree, with flowers and adult fruits), coll. J. G. Kuhlmann.

6. VIROLA PERUVIANA (A. DC.) Warb. A medium-sized tree of the scarcely inundable forest along the banks of the Rio Purús above the mouth of the Rio Acre (State of Amazonas) corresponds rather well to the description in Warburg's monograph, but the leaves are membranous. Out of many floriferous individuals I have found only male trees (Herb. Jard. Bot. Rio 24552).

7. VIROLA RUFULA Warb. Our herbarium specimens, viz. 24495 (male), 24497 (female, floriferous) and 24496 (fructiferous), from São Paulo de Olivença (Rio Solimões), 24498 (male), from S. Gabriel (Upper Rio Negro), correspond very well to the description in Warburg's monograph, the type coming from Coary (Rio Solimões). This species differs very little from *V. sebifera*, but its leaves are a little more oblong-lanceolate, membranous, pale or glaucous, and very scantily hairy beneath; the fruit resembles that of *V. sebifera*, having the same dense but deciduous ferruginous tomentum of minute stellate hairs. It grows to medium size in upland forest, especially where the growth is less dense or partly secondary.

We have also nos. 24541, 24542, and 24544, all male, from the upland forest northeast of Manáos, where the trees grow in the same conditions as above mentioned, which probably belong to the same species. Their leaves vary greatly in width, sometimes on the same branch; many of them have the broad form of those of *V. sebifera*, while others are narrow and oblong-lanceolate as in *V. cuspidata:* texture, color, and the faint tomentum are as in true *V. rufula*. I have not seen fructiferous material. No. 24545, male, from the Upper Rio Negro at the limit between the upland and the inundable vegetation, differs from the others only in its still longer leaf-apex. No. 24505, female, floriferous, from the Rio Ouro Preto, affluent of the Rio Pacanova, northwestern Matto Grosso, has more elongate leaves and more developed tomentum.

8. VIROLA THEIODORA (Spruce ex Benth.) Warb., from Manáos, may not differ from *V. rufula*, but according to the description the leaves are broader and thicker. We may, however, note that the type consists of fructiferous twigs. Warburg considers the rugose or undulate testa as the best differential character, but the fruits he had seen were not ripe, and their seeds may have become rugose when dry. The tea-smell, referred to by Spruce, can be

noted in dry leaves of many of the *Virola* species; it is not restricted to *V. theiodora*.

9. VIROLA CUSPIDATA (Benth.)Warb. (*V. elongata* (Benth.) Warb.) Very similar to certain forms of *V. rufula*, but the trees are always small; the leaves are extremely variable in the width of the base but are more distinctly lanceolate-oblong or ovate-lanceolate, terminating often in a very long point; they are always less tomentose than those of *V. sebifera*, but more strongly tomentose than those of *V. rufula;* the fruits are a little smaller than in either, and are globose rather than ellipsoid, having the same tomentum. This species is limited to the margins of lakes and rivers of the Middle and Upper Amazon, periodically subject to a long and deep inundation; in many parts of the Rio Negro, Trombetas, and Tapajoz it is a common and characteristic element of the flora. I have not as yet observed any other Myristicaceae in identical conditions except *V. surinamensis*, which is confined, in Amazonia, to the estuary and coastal region. I have observed *V. cuspidata* also in Upper Amazonia, at the Lower Javary, and Ule collected it at the Lower Juruá (5024) and at the Juruá Miry, Territory of Acre (5709). Our herbarium specimens come from the environs of Manáos (Rio Tarumá, Herb. Jard. Bot. Rio 24467, and Uypiranga, 24770, male plants; Lake Marapatá, 24469, fructiferous plant), from the Upper Rio Negro above the mouth of the Curicuriary (24446, male), from Boa Vista do Arary down to Itacoatiara (24465, male), and from Itaituba, Rio Tapajoz (24468, fructiferous).

I fail to find any distinctions between *V. cuspidata* and *V. elongata;* both leaf forms are very often found in the same tree. The varieties *punctata* and *membranacea* are only insignificant forms. I do not know whether *V. elongata* var. *subcordata* should be included here, as I have only seen an old male specimen from the Cassiquiare region (*Spruce* 3172).

10. VIROLA VENOSA (Benth.) Warb. This species, widely distributed through the hylaea from the coastal region to the Upper Amazon, is an upland forest tree, of small or middle size when in secondary formations, but rather large when in virgin growth. Frequent near Manáos (Herb. Jard. Bot. Rio 24500, male; 24499, female tree, floriferous and fructiferous); these specimens are exactly like the type, which I have seen. The ripe fruits are 15–18 mm long and 12–14 mm thick; they resemble in form and in the tomentum (which is ferruginous, deciduous, and composed of minute stellate hairs) those of *V. sebifera*, having a little thicker pericarp; the red arilloid is laciniate. These fruits are not described in Warburg's monograph; they have nothing to do with the fruits of *V. venosa* var. *pavonis* Warb. (of Andean Peru), which evidently does not belong to our species, having axillary inflorescences (the true *V. venosa* seems to have always pseudo-terminal inflorescences, sometimes at the summit of leafless lateral twigs). *V. venosa* var. *martii* Warb., from the Japurá, has also much larger fruits than our species and must be separated from it.

I have also gathered male plants of *V. venosa:* near Belem do Pará (Herb. Amaz. Mus. Pará 15849); at Bargança near the eastern Atlantic coast of Pará (Herb. Jard. Bot. Rio 19569, slightly different from the species type in its leaf base, which is nearly as acute as in *V. surinamensis*); at Itaituba and along the lower cataracts of Rio Tapajoz (Herb. Jard. Bot. Rio 18630 and 2702); in the Lower Trombetas region (Herb. Amaz. Mus. Pará 12042); near Tocantins, Upper Amazon (Herb. Jard. Bot. Rio 19570). Certain leaves of the last specimen have nearly parallel sides as in *V. carinata*, but the inflorescences are surely those of *V. venosa*. I have also seen a specimen collected at the Rio Marmellos, tributary of the Lower Madeira (*Ule* 6115, male).

11. VIROLA SURINAMENSIS (Rol.) Warb. This widely distributed and well known species grows in some of the Lesser Antilles, Trinidad, the Guianas, southern Venezuela, and the northernmost part of the Brazilian State of Amazonas (Rio Surumú, *Ule* 7988), the coastal region of Pará including the whole Amazon estuary, the northern part of Maranhão, and northwestern Ceará (Comarca de Granja, foot of the Serra Ibiapaba, in marshy ground near water, M. A. Lisboa, Herb. Mus. Pará 2436). It is extremely abundant in the low islands of the great estuary, inundable by the Atlantic tide; in some of these it represents the majority of the rather large trees up to 20 meters high. The enormous quantities of "ucuhúba" seeds yearly exported from Pará, or there consumed in industries, come from this species. By its rather large globose, glabrous fruits, it is distinguishable easily from other species, certain forms of which may resemble it (e.g. *V. carinata*, *V. venosa*).

12. VIROLA CARINATA (Benth.) Warb. A middle-sized or rather large tree which grows along small upland forest streamlets in marshy but not inundable soils. Frequent around Manáos (Herb. Jard. Bot. Rio 24503, male; 24502, female, floriferous; 24501, fructiferous); collected also at S. Paulo de Olivença (Herb. Jard. Bot. Rio 24504, fructiferous). The ripe fruits are 2–3 cm long and ellipsoid; their pericarp is thick, fleshy-coriaceous, glabrous, more or less twisted and roughly rugose when dry; the laciniate arilloid is purplish. The fruits do not attain the dimensions given for this species in Warburg's monograph; perhaps they are variable in size. I have not seen typical material of *V. carinata* but only a specimen of Spruce's No. 3206, distributed by its collector under the name *V. hypoleuca*, which is incorporated by Warburg in *V. carinata*. We must consult the great European herbaria to settle this question.

I refer to this species No. 11265 (fructiferous only) of the Herb. Amaz. Mus. Pará, from the Middle Trombetas, and the male plant Herb. Jard. Bot. Rio 21203, from Faro at the western limit of the State of Pará. The latter differs from the others by its smaller leaves with more acute base, nearly as in *V. surinamensis;* the tomentum is faint; the inflorescences, however, are as in *V. carinata*.

Virola elliptica A. C. Smith from the Upper Rio Machado, northwestern Matto Grosso, differs from *V. carinata*, according to the description, specially in having the fruits twice as long as broad (30 mm ×16 mm); the fruit of *V. carinata* would be, according to the same botanist, nearly globose and smaller. The male plant is, however, unknown.

The Peruvian species *V. weberbaueri* Mgf. (which I have not seen) is allied to *V. carinata*, according to the author, but to me it seems more like *V. albidiflora*, because of its large leaves with more numerous secondary ribs. But its very faint tomentum at once distinguishes it from that.

13. **Virola albidiflora** Ducke, n. sp. Arbor magna (circa 30 m) ramulis modice crassis plus minus tetragonis et sulcatis, novellis dense ferrugineo-tomentosis, vetustioribus subglabris. Foliorum petiolus 8–10 mm longus, crassus, tomentosus, vulgo fortiter canaliculatus; lamina saepius 15–25 cm longa et 4–6 cm lata, rarius usque ad 30 cm longa et ad 8 cm lata, in maioribus et medianis oblongo-lanceolata marginibus parallelis, in minoribus oblonga marginibus arcuatis, basi obtusa et complicata rarius anguste rotundata vel subcordata, apice brevissime acuminata vel acuta, margine in vetustioribus saepe revoluta, sat crasse herbaceo-coriacea fragilis, in adultis supra praeter costam tomentosam glabra, sub-opaca, in vetustis vulgo rugulosa, subtus dense et persistenter molliter canoferrugineo-pilosa sericeomicans, costa mediana supra plana subtus crasse convexa, costis lateralibus utrinque 28–35 supra immersis subtus valde prominentibus margine arcuato-conjunctis, venulis supra immersis subtus pilositate occultis. Inflorescentiae ad axillas superiores; masculae saepius ad 15 rarius 20 cm longae multiramosae, pedunculo et ramis primariis validis, undique et flores extus dense canotomentosae, bracteis latis tenuiter canosericeis ante anthesin caducis, florum fasciculis anthesi circa 5–7 mm latis, pedicellis et floribus vix ad 1 mm longis; flores albidi perigonio infundibuliformi ad medium trifido lobis rotundatis, intus glabro, antheris 3 connatis apice obtusis quam columna glabra distincte brevioribus et latioribus. Inflorescentiae femineae floriferae ignotae; fructiferae masculis multo breviores, pedunculo rhachidibus et pedicellis (his brevissimis) crassis, fructibus maturis 3–4 cm longis et circa 20 mm latis ellipsoideis glabris, pericarpio crasso carnoso-coriaceo siccitate irregulariter rugoso et saepe torto, semine longitudinaliter sulcato arillodio purpureo praeter basin laciniato.

Habitat in civitate Amazonas, silvis non inundatis secus ripas paludosas rivulorum, leg. A. Ducke prope São Paulo de Olivença, florif. 3-10-1931, Herb. Jard. Bot. Rio 24563 (mas), fructibus maturis 25-2-1932, Herb. Jard. Bot. Rio 24564; circa Manáos (versus Marapatá) florif. 31-8-1931, Herb. Jard. Bot. Rio 24562 (mas). Specimina 24563 a 24562 differunt columna androecei longiore et graciliore, caeterum non distinguenda.

This species has a certain affinity with *V. carinata*, but its leaves are very much larger, with more numerous nerves, and are densely tomentose beneath; its whitish staminate flowers are much smaller. The fruits differ from those of *V. carinata* only in size; they are among the largest of the genus.

14. **Virola minutiflora** Ducke, n. sp. Arbor sat magna, innovationibus tenuiter rufotomentosis, ramulis cito subglabris modice crassis obsolete quadrangulis fortiter rugoso-striatis. Foliorum petiolus 8–12 mm longus, modice robustus, parum canaliculatus, rugosus, subglaber; lamina 8–15 cm

longa et 3–5 cm lata, obovato-oblonga, basin versus vulgo sat longe cuneata, basi ipsa anguste cordata vel rotundata rarius obtusa, marginibus lateralibus arcuatis, apice breviter subabrupte acuminata, subcoriacea, parum discolor, supra parum subtus vix nitidula, adulta supra praeter costam medianam (immersam, tenuiter tomentosam) glabra, subtus tomento minutissimo pallido induta et pilis stellatis ferrugineis maioribus punctulata, costa mediana subtus crasse prominente, costis lateralibus (utrinque 30–38) in pagina superiore impressis, in inferiore prominentibus ante marginem evanescentibus, venulis nullis vel obsoletissimis. Inflorescentiae masculae (solae notae) e ramulis novellis infra folia nondum evoluta, 2 vel 4 per ramulum, vix usque ad 7 cm longae, pauciramosae, rufotomentosae, florum fasciculis 3–5 mm in diametro, multifloris, densissimis, ante anthesin bracteis latis medio acutis parum tomentellis involucratis, floribus ferrugineis, pedicello vix ad 1 mm longo, perigonio 0.6–0.8 mm longo infundibuliformi ad medium trifido extus tomentoso, antheris 3 connatis sublinearibus subacutiusculis quam columna gracilii glabra aliquanto brevioribus et latioribus. Arbor feminea ignota.

Habitat circa Manáos (civitate Amazonas), silva non inundabili, leg. A. Ducke loco Cachoeira Grande 8-8-1929 (Herb. Jard. Bot. Rio 24559), et circa locum Villa Belisario 31-8-1931 (Herb. Jard. Bot. Rio 24560).

This new species seems to occupy an intermediate place between *V. rugulosa* and *V. venosa*, but differs from both by more numerous leaf-nerves. The inflorescences are inserted on the basal part of the young branchlets, under the as yet undeveloped leaves, whereas the old branches often lose their foliage. It differs from the other species with very numerous leaf-nerves by the smaller leaves and inflorescences, by the relatively faint tomentum, and by the exceedingly small flowers (the smallest of the genus).

15. **Virola crebrinervia** Ducke, n. sp. Arbor sat magna innovationibus fugaciter canoferrugineo-tomentosis, ramulis modice robustis obsolete quadrangulis cito subglabris. Foliorum petiolus 5–7 mm longus modice robustus late et profunde canaliculatus, tomentosus, tardius plus minus glabratus; lamina 10–18 cm longa et 2.2–3 cm lata, anguste oblongo-lanceolata marginibus subparallelis, basi vulgo distinctissime cordata, apice subsensim brevius vel longius vulgo acutissime caudato-acuminata, membranacea, utrinque cito glabra, supra fuscescens subtus ferruginescens, supra parum subtus vix nitidula, costa mediana subtus sat crassa, costis lateralibus in utroque latere 50–56 subtus tenuiter at distincte prominentibus, parum ante marginem arcuato-anastomosantibus, venulis utrinque sub lente tenuiter reticulatis. Inflorescentiae masculae (solae notae) in ramulo infra folia ut videtur vulgo duae, ad 13 cm longae, sat floribundae, canoferrugineo-tomentosae, florum fasciculis 3–5 mm diametro multifloris densis ante anthesin bractea lata dense tomentella involucratis; flores pedicello vix ad 1 mm longo, perigonio vix ad 1.5 mm longo anthesi infundibuliformi ad medium trifido extus tomentoso, antheris 3 connatis sublinearibus connectivo brevissime apiculatis quam columna gracili glabra aliquanto brevioribus et latioribus. Arbor feminea ignota.

Habitat prope Gurupá (in civitate Pará), silva humidissima non inundabili 10-8-1918 leg. A. Ducke (Herb. Amaz. Mus. Pará 17182).

This belongs to a group of four species characterized by the presence of 50 to 60 pairs of lateral leaf-ribs. It is distinguished from the three others

(*V. multicostata*, *V. multinervia*, and *V. decorticans*) by the narrow lanceolate leaves with nearly parallel sides (as in *V. surinamensis* and others). It has also a certain affinity with *V. minutiflora*, but differs in the form of the leaves and in their much more numerous ribs.

16. **Virola multicostata** Ducke, n.sp. Arbor elata ramulis crassis fortiter rugosis, partibus vegetativis solum vetustis visis glabratis. Foliorum petiolus 10–12 mm longus sat robustus vix canaliculatus; lamina 20–28 cm longa, 7–9.5 cm lata, oblonga, basi subcordata apice breviter abrupte acuminata, chartacea, costis utrinque 50–60 supra immersis subtus fortiter prominentibus parum ante marginem arcuato-anastomosantibus. Inflorescentiae masculae circa 15 cm longae ramosae floribundae, undique canotomentosae, florum fasciculis 3–5 mm diametro, densis, multifloris, floribus vix ad 1 mm pedicellatis, perigonio 1 mm parum longiore anthesi infundibuliformi ad medium trifido, extus dense tomentoso, antheris 3 connatis sublinearibus connectivo brevissime apiculato columnae gracili subaequilongis at magis latis. Arbor feminea ignota.

Habitat in regione Rio Branco de Obidos (in civitate Pará) loco Castanhal Grande silva non inundabili, 27-12-1913 leg. A. Ducke (Herb. Amaz. Mus. Pará 15257).

This species belongs to a group remarkable for the very great number of lateral leaf-ribs, viz. *V. multinervia*, *V. decorticans*, and *V. crebrinervia*. It differs from *V. multinervia* by the smaller and nearly parallel-sided leaves, the scarcely visible reticulate veins, and the inflorescences covered with a tomentum of much shorter hairs, which cover also the perigonia; from the two other mentioned species, by its very different leaves and many other characters. Unfortunately we have only very incomplete herbarium material of this species: a branchlet, some old leaves, and some male inflorescences, all of them gathered under the tree. I publish a description because I suppose we may always recognize this species on the basis of leaf characters.

17. **Virola multinervia** Ducke, n.sp. Arbor vulgo sat magna (20–30 m), ramulis subtetragonis, annotinis densissime fulvovillosis, hornotinis glabris crassis. Foliorum petiolus 5–10 mm longus crassus dense fulvotomentosus, supra canaliculatus; lamina vulgo 20–40 cm longa et 8–14 cm lata, obovato-vel ovato-oblonga, basi saepissime sat angusta plus minus cordata, apice abrupte caudato-acuminata acumine saepius brevi et falcato, subcoriacea, parum discolor, adulta supra praeter costam glabra subtus dense et longe canescenti-stellatopilosa, utrinque opaca vel praesertim supra plus minus nitida, costa mediana in utraque pagina dense cano-vel fulvo-villosa, subtus crassius prominente, costis lateralibus (utrinque 45–58, saepe fere horizontalibus) et venulis transversis supra impressis subtus prominentibus, costis prope marginem reticulato-anastomosantibus minus distincte arcuato-conjunctis. Inflorescentiae 2 e ramuli annotini parte basali infra folia, rhachidibus dense fulvovillosis. Inflorescentiae masculinae vulgo ultra 20 cm longae, multiramosae, ramulis ultimis gracilibus, bracteis late ovatis medio acuminatis tenuiter tomentosis 5–6 mm longis et latis, anthesi caducis, florum fasciculis multifloris diametro 5–6 mm, pedicellis 1–2 mm longis tenuissimis longe et sat sparsim pilosis; flores albi, siccitate fusci, perigonio 1–1.5 mm longo infundibuliformi ad medium trifido apice extus et praesertim ad margines longe et parce piloso, antheris 3 (an semper?) connatis linearibus

apice acutiusculis, quam columna gracili glabra parum brevioribus et latioribus. Inflorescentiae femininae quam masculae breviores (non ultra 15 cm longae), rhachidibus robustioribus minus ramosis, bracteis et floribus aliquanto maioribus, his crassioribus extus dense tomentosis, fulvis, pedicello crasso brevissimo; ovarium dense rufotomentosum stylo glabro. Fructus adultus circa 2.5–3 cm longus et circa 2 cm crassus, oblongo-ellipticosubobovatus, breviter crasse pedicellatus, pilis 0.5–1.5 mm longis ramulis brevissimis alternis munitis post maturitatem persistentibus dense rufofulvo-subhispido-velutinus, pericarpio crasso, semine longitudinaliter sulcato arillodio laciniato purpureo.

Habitat non infrequens in silvis non inundatis circa Manáos (civ. Amazonas), loco Estrada do Aleixo legit A. Ducke: arbor feminea florifera 15-5-1932, fructibus maturis 9–12 (cum ligni numero 100), Herb. Jard. Bot. Rio 24555; arbor mascula florifera 16-5-1933, Herb. Jard. Bot. Rio 24556. Ad ipsam speciem evidenter pertinent specimina fructifera a J. G. Kuhlmann lecta in Peruvia orientali prope Yurimaguas, typo similia at petiolis longioribus (ad 18 mm), foliis basi profundius cordatis apice vix caudato-acuminatis, pilositate aliquanto breviore (Herb. Jard. Bot. Rio 24557).

This beautiful species is not rare in the upland virgin rain-forests north of Manáos; it has been collected also in eastern Peru. It is remarkable for the large leaves with very numerous lateral ribs recalling only those of *V. decorticans*. The male inflorescence resembles that of *V. rugulosa* Warb. (Upper Rio Negro), the leaves of which have, however, much fewer nerves, as also in the allied *V. mycetis* Pulle, of Surinam.

18. **Virola decorticans** Ducke, n.sp. Arbor mediocris. Ramuli subcompressi, ut in variis generis *Vochysia* speciebus in laminas magnas decorticantes, cortice dense rufovelutino, hornotini crassi, apice ramulum annotinum foliosum et inflorescentiam gerentes ibique tegumentis magnis foliaceis persistentibus e gemmis oriundis involuti. Foliorum petiolus 1–2 cm longus robustissimus dense rufovelutinus supra leviter canaliculatus, lamina in speciminibus nostris 52–60 cm longa, 15–21 cm lata, oblongo-obovata basin versus longe cuneata, basi anguste cordata vel rotundata, apice abrupte caudato-acuminata acumine longe subulato, herbaceo-coriacea, supra glaucescens subnitida, subtus ferruginea opaca, costa mediana in utraque pagina rufovelutina subtus valde crassa, costis literalibus (utrinque 52–56) et venulis transversis supra immersis subtus prominentibus, costis margine arcuatim conjunctis, pilis steliatis pro genere longis in utraque pagina persistentibus, in superiore magis dispersis, in inferiore praesertim in nervis et venulis densioribus. Inflorescentia feminea solum fructifera nota, ex apice rami hornotini ad basin ramuli annotini foliiferi oriunda, 12–16 cm longa, pauciramosa, pedunculo et rhachidibus robustis dense rufovelutinis, bracteis nonnullis persistentibus 6–15 mm longis oblongo-vel ovato-lanceolatis utrinque tenuiter canosericeis; fructus (ut videtur adultus) oblongo-ovatus vel ellipsoideus 2.5–3.5 cm longus 1.8–2.2 cm latus, vix brevissime pedicellatus, pilis 2–2.5 mm longis alterne brevissime spinuloso-ramosis persistentibus dense rufo-subhispido-velutinus. Inflorescentia mascula quam feminea maior ampla multiramosa, rhachide et ramulis tenuibus dense rufovillosis pilis spinulosis, bracteis ovatis vulgo acutis utrinque rufotomentosis, 6–10 mm longis, anthesi persistentibus, florum fasciculis multifloris diametro 6–10 mm, pedicellis 1–3 mm longis tenuibus longiuscule et sat dense pilosis; flores siccitate ferruginei perigonio 1–2 mm longo anthesi anguste infundibuliformi

fere ad basin trifido extus et ad margines densiuscule sat breviter piloso, antheris 3 connatis linearibus apice acutiusculis quam columna gracili distincte latioribus at vix longioribus.

Habitat prope São Paulo de Olivença (Rio Solimões, in civitate Amazonas), silva humida non inundabili prope rivum Jaratuba, planta feminea, leg. A. Ducke 4-11-1927, Herb. Jard. Bot. Rio 19571; in Peruvia orientali: Victoria, Rio Amazonas, Depart. Loreto, L. Williams 3077, planta mascula (sub nomine *V. mollissima* distributa, inflorescentiam solam vidi).

This magnificent species cannot be mistaken with any other, because of the deciduous cortex of the branchlets and the enormous leaves, hairy on both sides. The very numerous lateral leaf-ribs and the fruit covered with hispid-velvety spur-ramified persistent hairs recall *V. multinervia*.

19. VIROLA CALOPHYLLA Spruce ex Warb. This species can be confused only with *V. calophylloidea* Mgf., from which it differs in the much larger leaves and inflorescences, the more ferruginous tomentum, and certain other less important characters; the fruit is a little more ellipsoid, very finely granulose-rugose. The tree, commonly of a middle size, grows in the upland virgin forest of the western and central parts of the Amazonian plain, from the Middle Tapajoz to Iquitos, Eastern Peru. Our specimens come from the Tapajoz river near the lowest cataracts (Herb. Jard. Bot. Rio 18632, male), from the environs of the lake José-Assú near Parintins (Herb. Jard. Bot. Rio 24487, male), from the Rio Purús near the mouth of the Rio Acre (Herb. Jard. Bot. Rio 24486, male), and from S. Paulo de Olvença (Herb. Jard. Bot. Rio 24494, male, and 24485, fructiferous). I have also seen a male specimen from Seringal S. Francisco, Territory of Acre (*Ule* 9376). The type is from the Upper Rio Negro.

20. VIROLA CALOPHYLLOIDEA Mgf. This species is allied to *V. calophylla* but differs constantly by its smaller leaves (not exceeding 35 cm by 8 cm), often oblong-lanceolate with rounded or obtuse base (rarely cordate) and with longer acuminate apex, having 12–18 (more frequently 15 or 16) pairs of secondary ribs; by the brownish red rather than ferruginous tomentum of the inflorescences, flowers, and fruits; by the short (1.5–3.5 cm) male inflorescences; by the very short and poor female inflorescences, which nearly lack a common peduncle; by the more clavate staminate flowers, only trilobate in their terminal quarter; by the androecium column distinctly longer than the anthers and in its superior third suddenly narrowed in the form of a cylindric neck. The fruits, in our specimens, are more obovate, with still finer rugosities than in the specimens of *V. calophylla* in our collection, but I do not know whether this difference is constant; they are 1.5–2 cm long and 1 cm broad below the apex, very finely rugose, densely tomentose with microscopic stellate hairs persisting after maturity; their pericarp is not very thick but is rigid; the scarlet arilloid is laciniate, except at the base.

This small tree is not very rare in the undergrowth of the upland virgin forests near Manáos, but has not yet been gathered elsewhere. Our herbarium specimens come from the forests along the "Estrada do Aleixo"

(Herb. Jard. Bot. Rio 24539, male) and northeast of Flores (Herb. Jard. Bot. Rio 24540, female). I have compared them with a cotype (*Ule* 8846).

21. **Virola parvifolia** Ducke, n.sp. Arbor mediocris, ramulis sat tenuibus glabris longitudinaliter striatis et distincte rugoso-tuberculatis, obscure rufis demum atrofuscis. Folia petiolo 6–14 mm longo robusto glabro, tuberculato, supra plus minus canaliculato; lamina vulgo 5–10 (rarius 3–5 vel 10–11) cm longa et 3–5 cm lata, ovato-elliptica, basi obtusa, apice obtusa vel saepius brevissime late et obtuse acuminata et retusiuscula, margine tenuiter revoluto subtus lineiformi-elevato, coriacea, solum novissima fugaciter tomentosa cito glabra, vix discolor, supra nitida subtus opaca, in utraque pagina sub lente dense minute tuberculato-granulata, costa mediana supra impressa subtus prominente, costis secundariis utrinque 12–16 parallelis vix curvatis in utraque pagina tenuissimis vel subobsoletis ante marginem evanescentibus. Inflorescentiae masculae (solae notae) in axillis superioribus, folia excedentes, usque ad 120 mm longae, longe pedunculatae, pauciramosae, rhachidibus tuberculatis glabris solum partibus novissimis fugaciter puberulis, bracteis caducissimis non visis, fleorum fasciculis paucis dissitis diametro 5–7 mm, pedicellis gracilibus ad 2 mm longis canotomentellis. Flores ferruginei, 1.5–2 mm longi, infundibuliformes, ad medium trifidi, extus tenuiter canopuberuli, intus glabri tenuissime rugulosi; staminum columna glabra, gracilis medio parum incrassata, quam antherae (tres in floribus examinatis, apice subobtusae) multo longior iisque subaequilata. Planta feminea ignota.

Habitat in silvis humilioribus solo humo-silicoso, "catingas" dictis, prope Camanáos (Rio Negro superiore, in civitate Amazonas), 12-10-1932 leg. A. Ducke (Herb. Jard. Bot. Rio 24553).

This new species occupies an isolated position with the genus. The small glabrous leaves and their peculiar nervation, the relatively long but few branched and nearly glabrous inflorescences, and the small granules or tubercles, numerous and very conspicuous on the branchlets, leaves, and peduncles, are characteristics which preclude mistaking this for any other species.

Obituary

DR. WILLIAM HOLLAND WILMER, distinguished ophthalmologist and for many years a member of the Washington Academy of Sciences, died suddenly at his home on March 12, 1936. The son of the Right Reverend Richard Hooker and Margaret (Brown) Wilmer, he was born in Powhatan County, Va., August 26, 1863.

His preliminary education was received at the Episcopal High School, Alexandria, Va., and he was graduated in medicine from the University of Virginia in 1885. His post-graduate training was at Mt. Sinai Hospital, New York; at the New York Polyclinic and at various hospitals in Europe.

Dr. Wilmer thereafter served as assistant to the late Dr. Emil Gruening until 1889 when he commenced private practice in Washington. In 1891 he married Miss Re Lewis Smith of Pennsylvania.

In Washington Dr. Wilmer rapidly became the leading ophthalmologist and his skill, united with his gracious personal qualities, attracted to him patients from the entire country, particularly the South. During the first period of Washington residence, he was an active member of the staff of the Episcopal Eye, Ear and Throat Hospital and consulting ophthalmologist on the staffs of a number of the general hospitals. In 1906 he became Professor of Ophthalmology at the Georgetown University School of Medicine.

In 1911 Dr. Wilmer was commissioned a lieutenant in the Medical Reserve Corps, U. S. Army, and at the beginning of the World War he was promoted to major and placed at the head of the Medical Research Laboratory of the Air Service at Mineola, L. I. His work there proved so valuable that he was, at General Pershing's request, sent to France where he carried forward similar researches for the A. E. F. He was awarded the Distinguished Service Medal in 1919 and relinquished his connection with the army with the rank of Brigadier General. In 1924 he was decorated with the cross of the Legion of Honor of France.

Dr. Wilmer resumed his private work in Washington after the war, but in 1925 he went to Baltimore to become Director of the Wilmer Institute of Ophthalmology, a research unit of the Johns Hopkins Hospital, which was created as a tribute to him largely by the gifts of his patients and friends. In addition to the directorship of the Institute, he was Professor of Ophthalmology of the Johns Hopkins Medical School and ophthalmologist in chief of the Johns Hopkins Hospital. He retired from these positions in 1934 and returned to his earlier home and work in Washington.

Dr. Wilmer was a frequent contributor to the periodic literature on ophthalmology, but his outstanding publication is *The atlas fundus oculi*, a beautiful volume with 100 colored plates. He was a member and past president of the American Ophthalmological Society; a director of the National Committee for the Prevention of Blindness; a member of the Advisory Committee for the Prevention of Hereditary Blindness; of the National Institute of Social Science; of the National Committee on Mental Hygiene; of the American Association for the Advancement of Science; a Fellow of the American Medical Association; a founder and Fellow of the American College of Surgeons; a member of the Medical Society of the District of Columbia; of the Southern Medical Association; of the Army and Navy Air Service Association; of the Medical Air Service Association; of the Association of Military Surgeons of the U. S. He was also an honorary member of the Oxford Ophthalmological Society of England; of the Hungarian Ophthalmological Society; of the Chicago Ophthalmological Society; and of the

Saranac Medical Society. He was given honorary degrees by Georgetown, Princeton, New York, and Johns Hopkins Universities.

AUGUST FREDERICK FOERSTE, associate in paleontology at the U. S. National Museum since 1932, died April 23, 1936, at the home of relatives at Dayton, Ohio. Doctor Foerste was born May 7, 1862, at Dayton, Ohio. He received the A.B. degree in 1887 and the Sc.D. degree in 1927 from Denison University; the A.M. in 1888 and Ph.D. in 1890 from Harvard University. From 1890 to 1892 he studied petrography at Heidelberg and Paris.

Doctor Foerste's vocation was the teaching of physics from 1893 to 1932 at the Steele High School, Dayton, Ohio. His avocation in the meantime was research in paleontology in which capacity at one time or other he was employed by the U. S. Geological Survey, Canadian Geological Survey, and the Indiana, Kentucky, and Ohio State Surveys. He became a distinguished authority on Ordovician and Silurian faunas with which his numerous publications largely deal. Upon retirement from teaching in 1932 he came to the National Museum as an associate in paleontology and devoted his time and energy to the preparation of a monograph on early Paleozoic cephalopods.

Doctor Foerste was a member of the Geological Society of America; the Paleontological Society of America, of which he was the president in 1928; the American Association for the Advancement of Science; the Ohio Academy of Science, of which he was the president in 1931; Washington Academy of Sciences; and he was one of the two honorary members of the Engineers' Club of Dayton, the other being Wilbur Wright. He was the representative of the Paleontological Society of America to the National Research Council.